

What is Claimed:

1. A method of specifically and selectively up-regulating the gene expression of bone morphogenetic protein(s) in tissue, comprising the steps of:
 - a. generating at least one specific and selective signal that has signal characteristics that are selected to up-regulate the gene expression of bone morphogenetic protein(s) (BMPs) as measured by mRNA when said signal is applied to the tissue; and
 - b. exposing the bone tissue to a field generated by the specific and selective signal for a predetermined duration of time at predetermined intervals so as to up-regulate the expression of BMPs as measured by mRNA.
2. The method of **claim 1** wherein the generating step comprises the step of selectively varying the amplitude, duration, duty cycle, frequency, and waveform of the specific and selective signal until the up-regulation of the gene expression of BMPs as measured by mRNA in bone tissue by the generated field is substantially increased.
3. The method of **claim 1** wherein said generating step comprises the step of generating the specific and selective signal at a remote source and said exposing step comprises the step of applying the field generated by the specific and selective signal to the bone tissue.
4. The method of **claim 3** wherein the exposing step comprises the step of applying the specific and selective signal to electrodes, coil(s) or a solenoid located near the bone tissue.
5. The method of **claim 4** wherein the exposing step comprises the step of applying the field generated by the specific and selective signal to the bone tissue through one of capacitive coupling and inductive coupling.
6. The method of **claim 5** wherein the specific and selective signal causes the electrodes to generate one of a capacitive coupling electric field and the coil(s) or solenoid to generate an electromagnetic field or a combined field.
7. A method for treating at least one of a bone fracture, fracture at risk, delayed union, nonunion, bone defect, spine fusion, osteonecrosis, and osteoporosis, comprising the steps of:
 - a. generating at least one specific and selective signal that up-regulates the gene

expression of bone morphogenetic protein(s) as measured by mRNA; and

b. exposing bone tissue to a field generated by the specific and selective signal for a predetermined duration at predetermined intervals so as to selectively up-regulate gene expression of bone morphogenetic protein as measured by mRNA.

8. The method of **claim 7** wherein the exposing step comprises the step of capacitively coupling the field to bone tissue.

9. The method of **claim 7** wherein the exposing step comprises the step of applying one of an electromagnetic field and a combined field to bone tissue.

10. The method of **claim 7** wherein the generating step comprises the step of generating an electric field having an amplitude of approximately 20 mV/cm, a sine wave configuration, a duty cycle of approximately 50%, and a frequency of approximately 60 kHz.

11. The method of **claim 10** wherein the exposing step comprises the step of applying the electric field to the bone tissue for a duration of approximately 24 hours every 24 hours.

12. The method of **claim 11** wherein the exposing step comprises the step of applying the electric field to the bone tissue for a 50% duty cycle of 1 minute ON and 1 minute OFF.

13. The method of **claim 7** wherein the generating step comprises the steps of selectively varying the amplitude, duration, duty cycle, frequency, and waveform of the specific and selective signal until the up-regulation of the gene expression of bone morphogenetic protein(s) as measured by mRNA in the bone tissue by the generated field is substantially increased.

14. The method of **claim 13** wherein the exposing step comprises the step of applying the field generated by the specific and selective signal to the bone tissue through one of capacitive coupling and inductive coupling.

15. The method of **claim 14** wherein the specific and selective signal causes electrodes applied to the patient's skin to generate one of a capacitive coupling electric field, an electromagnetic field, and a combined field.

16. A device for the treatment of at least one of bone fractures, fractures at risk, delayed unions, nonunions, bone defects, spine fusion, osteonecrosis, and osteoporosis, comprising a signal source that provides at least one signal that creates a field specific and selective for up-regulating gene expression of bone morphogenetic protein(s) as measured by mRNA, and electrodes or coil(s) connected to the signal source that receive said at least one specific and selective signal for application of the field to the bone tissue for a predetermined duration at predetermined intervals so as to selectively up-regulate gene expression of bone morphogenetic protein(s) as measured by mRNA in said bone.

17. The device of **claim 16** further comprising a portable power unit that drives said signal source.

18. The device of **claim 16** further comprising means for attaching the electrodes to the body of a patient in the vicinity of bone tissue.

19. The device of **claim 16** further comprising means for attaching the signal source to the body of a patient.

20. The device of **claim 16** wherein the field generated by said at least one specific and selective signal is applied to said bone tissue via one of capacitive coupling and inductive coupling.

21. The device of **claim 20** wherein the specific and selective signal has a sine wave configuration and generates an electric field having an amplitude of about 20 mV/cm at 60 kHz with approximately a 50% duty cycle.

22. A method of treating at least one of bone fractures, fractures at risk, delayed unions, nonunions, bone defects, spine fusion, osteonecrosis, and osteoporosis comprising the steps of exposing bone tissue to the specific and selective field generated by the device of **claim 21** so as to up-regulate gene expression of bone morphogenetic protein(s) as measured by mRNA in the bone tissue.

23. The method of **claim 22**, wherein the exposing step comprises the step of

applying the specific and selective field to the bone tissue for a duration of approximately 24 hours every 24 hours with a 50% duty cycle of 1 minute on and 1 minute off.

24. A method of determining a selective signal that generates an electric field that up-regulates bone morphogenetic protein(s), comprising the steps of selecting a starting signal with a signal shape and frequency known to increase or suspected to affect cellular production of bone morphogenetic protein(s), selectively varying a duration of application of said starting signal until a duration that provides a most significant increase of BMP(s) is found, varying an amplitude of said starting signal until an amplitude that provides a most significant increase of BMP(s) is found, varying a duty cycle of the starting signal until a duty cycle that provides a most significant increase of BMP(s) is found, and varying the duration of an on-off interval of the duty cycle of the signal until an on-off interval that provides a most significant increase of BMP(s) is found.

25. A method as in claim 24, comprising the further steps of selectively varying a frequency and waveform of said signal, keeping other signal characteristics constant, until a greatest increase in the gene expression of BMP as measured by mRNA is found.